

## CLAIMS

What is claimed is:

1       1. A system for measuring fluid in a container, the system comprising:  
2              one or more transducers operable to:  
3                  introduce a vibration to a container wall,  
4                  detect an introduced vibration that has propagated at least partially  
5              around a container wall, and  
6                  generate a signal representative of a detected vibration; and  
7              a computer operable to determine a state of a fluid in a container based on  
8              a signal representing an introduced vibration that has propagated at least partially around  
9              a container wall.

1       2. The system of claim 1, wherein the one or more transducers comprises a  
2      first transducer, the first transducer operable to introduce a vibration to a container wall.

1       3. The system of claim 2, wherein the first transducer comprises an air  
2      transducer.

1       4. The system of claim 2, wherein the first transducer generates a vibration  
2      between approximately 30 kHz and 150 kHz.

1       5. The system of claim 1, wherein the one or more transducers are adapted to  
2      couple to the exterior of a container.

1       6.     The system of claim 1, wherein a fluid state comprises a fluid level.

1       7.     The system of claim 1, wherein the computer determines a fluid state in a  
2     container based on the time for an introduced vibration to propagate at least partially  
3     around a container wall to a detecting transducer.

1       8.     The system of claim 1, wherein the computer determines a fluid state in a  
2     container based on the amplitude of an introduced vibration at detection.

1       9.     The system of claim 1, wherein the computer determines a fluid state in a  
2     container based on:  
3                  the time for an introduced vibration to propagate at least partially around a  
4     container wall to a detecting transducer; and  
5                  the amplitude of the introduced vibration at detection.

1       10.    The system of claim 1, wherein the computer is further operable to control  
2     an introducing transducer.

1       11.    The system of claim 10, wherein the computer is operable to control the  
2     amplitude and frequency of vibrations introduced by the introducing transducer.

1           12. The system of claim 1, wherein the computer is further operable to  
2       determine a second fluid state.

1           13. The system of claim 1, further comprising a wireless communication  
2       device operable to send a wireless signal representing a generated signal to the computer.

- 1        14. A method for measuring fluid in a container, the method comprising:
  - 2                introducing a vibration to a container wall;
  - 3                detecting the vibration in the container wall after the vibration has
  - 4                propagated at least partially around the container wall; and
  - 5                determining a state of a fluid in the container based on the detection of the
  - 6                vibration.

1            15. The method of claim 14, wherein determining a fluid state based on the  
2 detection of the vibration comprises determining the time for the vibration to propagate at  
3 least partially around the container wall to a detection point.

1            16. The method of claim 14, wherein determining a fluid state based on the  
2 detection of the vibration comprises determining the amplitude of the vibration at  
3 detection.

- 1            17. The method of claim 14, wherein determining a fluid state based on the
- 2            detection of the vibration comprises:
  - 3                determining the time for the vibration to propagate at least partially around
  - 4                the container wall to a detection point; and
  - 5                determining the amplitude of the vibration at detection.

1                   18. The method of claim 14, further comprising controlling the introduction of  
2                   the vibration.

1           19. The method of claim 14, further comprising sending a wireless signal  
2           representing the detected vibration.

1        20. A system for measuring fluid in a container, the system comprising:  
2                means for introducing a vibration to a container wall;  
3                means for detecting an introduced vibration that has propagated at least  
4                partially around a container wall and for generating a signal representing a vibration at  
5                detection; and  
6                means for determining a state of a fluid in a container based on a signal  
7                representing an introduced vibration that has propagated at least partially around a  
8                container wall.

1        21. The system of claim 20, wherein determining a fluid state comprises  
2                determining the time for an introduced vibration to propagate at least partially around a  
3                container wall to the detection means.

1        22. The system of claim 20, wherein determining a fluid state comprises  
2                determining the amplitude of an introduced vibration at detection.

1        23. The system of claim 20, wherein determining a fluid state comprises:  
2                determining the time for an introduced vibration to propagate at least  
3                partially around a container wall to the detection means; and  
4                determining the amplitude of the introduced vibration at detection.

1        24. The system of claim 20, wherein the determining means also controls the  
2                introducing means.

1        25. The system of claim 20, further comprising means for sending a wireless  
2 signal representing the generated signal to the determining means.

1        26. The system of claim 20, wherein the introducing means and the detecting  
2 means are adapted to couple to the exterior of a container.

1           27. A method for measuring fluid in a container, the method comprising:  
2                   receiving a signal representing a vibration detected after being introduced  
3                   to and propagating at least partially around a container wall; and  
4                   determining a state of a fluid based on the signal.

1           28. The method of claim 27, wherein determining a fluid state based on the  
2           signal comprises determining the time for a represented vibration to propagate at least  
3           partially around a container wall to a detection point.

1           29. The system of claim 27, wherein determining a fluid state based on the  
2           signal comprises determining the amplitude of a represented vibration at detection.

1           30. The method of claim 27, wherein determining a fluid state based on the  
2           signal comprises:  
3                   determining the time for a represented vibration to propagate at least  
4                   partially around a container wall to a detection point; and  
5                   determining the amplitude of the represented vibration at detection.

1           31. The method of claim 27, further comprising controlling the introduction of  
2           the represented vibration.

1           32. The method of claim 27, wherein receiving a signal comprises receiving a  
2           wireless signal representing the signal.

1       33. A system for measuring fluid in a container, the system comprising:  
2                   a computer operable to:  
3                       determine whether a signal representing a vibration detected after  
4                       being introduced to and propagating at least partially around a container wall has been  
5                       received, and  
6                       determine a state of a fluid based on the signal.

1       34. The system of claim 33, wherein determining a fluid state based on the  
2           signal comprises determining the time for a represented vibration to propagate at least  
3               partially around a container wall to a detection point.

1       35. The system of claim 33, wherein determining a fluid state based on the  
2           signal comprises determining the amplitude of a represented vibration at detection.

1       36. The system of claim 33, wherein determining a fluid state based on the  
2           signal comprises:  
3                   determining the time for a represented vibration to propagate at least  
4               partially around a container wall to a detection point; and  
5                   determining the amplitude of the represented vibration at detection.

1       37. The system of claim 33, wherein the computer is further operable to  
2           control the introduction of a vibration.

1       38. The system of claim 33, further comprising a wireless communication  
2 device operable to receive a wireless signal representing the signal.

1           39. An article comprising a machine-readable medium storing instructions  
2       operable to cause one or more machines to perform operations comprising:  
3               determining whether a signal representing a vibration detected after being  
4       introduced to and propagating at least partially around a container wall has been received;  
5       and  
6               determining a state of a fluid based on the signal.

1           40. The article of claim 39, wherein determining a fluid state based on the  
2       signal comprises determining the time for a represented vibration to propagate at least  
3       partially around a container wall to a detection point.

1           41. The article of claim 39, wherein determining a fluid state based on the  
2       signal comprises determining the amplitude of a represented vibration at detection.

1           42. The article of claim 39, wherein determining a fluid state based on the  
2       signal comprises:  
3               determining the time for a represented vibration to propagate at least  
4       partially around a container wall to a detection point; and  
5               determining the amplitude of the represented vibration at detection.

1           43. The article of claim 39, wherein the instructions are further operable to  
2       cause one or more machines to perform operations comprising controlling the  
3       introduction of a vibration.

1       44. The article of claim 39, wherein the instructions are further operable to cause one  
2       or more machines to perform operations comprising determining whether a wireless  
3       signal representing the signal has been received.

1           45. A system for measuring fluid in a container, the system comprising:

2                 a container for holding a fluid, the container comprising a wall having an

3             inner surface and an exterior surface;

4                 a first transducer coupled to the exterior surface of the container wall near

5             the top of the container, the first transducer operable to introduce a vibration to the

6             container wall;

7                 a second transducer coupled to the exterior surface of the container wall

8             near the top of the container, the second transducer operable to detect the vibration after it

9             has propagated at least partially around the container wall and to generate a signal

10           representative of the vibration at detection;

11                 a wireless communication device coupled to the second transducer, the

12           wireless communication device operable to send a wireless signal representing the

13           generated signal; and

14                 a second wireless communication device, the second wireless

15           communication device operable to receive the wireless signal;

16                 a computer coupled to the wireless communication device, the computer

17           operable to:

18                     determine if a signal representative of the vibration at detection has

19           been received;

20                     determine a fluid mass in the container based on the time for the

21           vibration to propagate at least partially around the wall from the first transducer to the

22           second transducer,

23                     determine a fluid volume based on the fluid mass,

24           determine a fluid level based on the fluid volume, and  
25           control the amplitude and frequency of the vibration introduced by  
26       the first transducer.